Assessing Core Flight System as Architecture for Potential Mars Ascent Vehicle Flight Software

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Agenda

- Project Overview
- Mission Overview
- Scope and Objectives
- Technical Results
- Next Steps

Project Overview and Background

- MSFC Technology Innovation Program seeks to develop and mature technologies or capabilities that will increase the Center's competitive capability and lead to future funding opportunities for the Center
- Software Development Branch proposed to survey existing core Flight System (cFS) applications and develop prototype cFS application source code to be run on a Sphinx Flight Computer to control a specific hardware component
- Collaboration with Mars Ascent Vehicle (MAV) study to develop prototype code for a notional Inertial Measurement Unit (IMU)

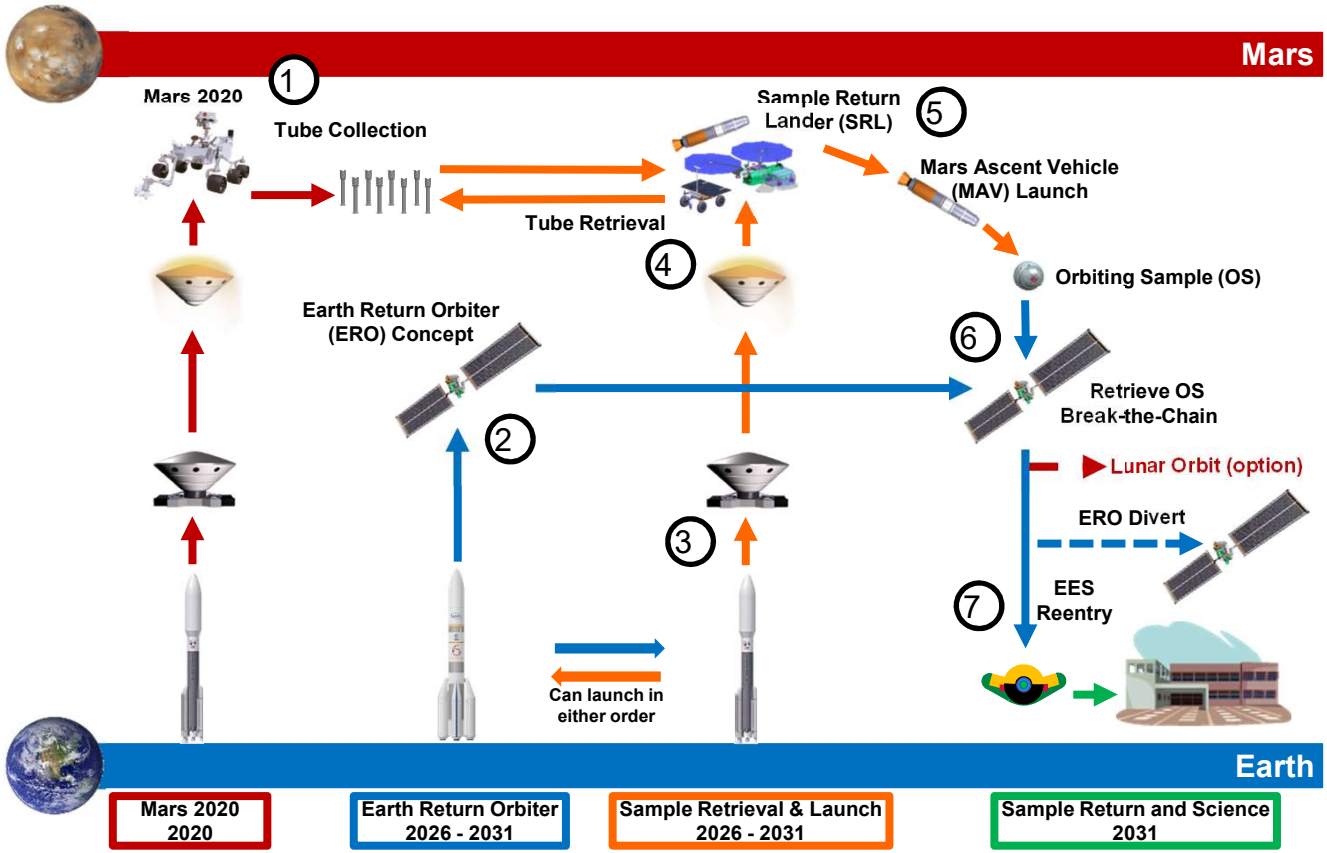
TIP Goals

- Develop additional capability in using the cFS architecture at MSFC
- Gain familiarity with running cFS on the Real-time Executive for Multiprocessor Systems (RTEMS) operating system on Sphinx flight computer
- Develop initial requirements and design documentation for IMU prototype
- Demonstrate working cFS code on Sphinx flight computer
- Consider ways to improve code for inclusion in a more generic portfolio of applications available at the start-up of a new project
- Apply this knowledge to MAV activity to prototype flight software early in project lifecycle

Conceptual MSR Mission Overview

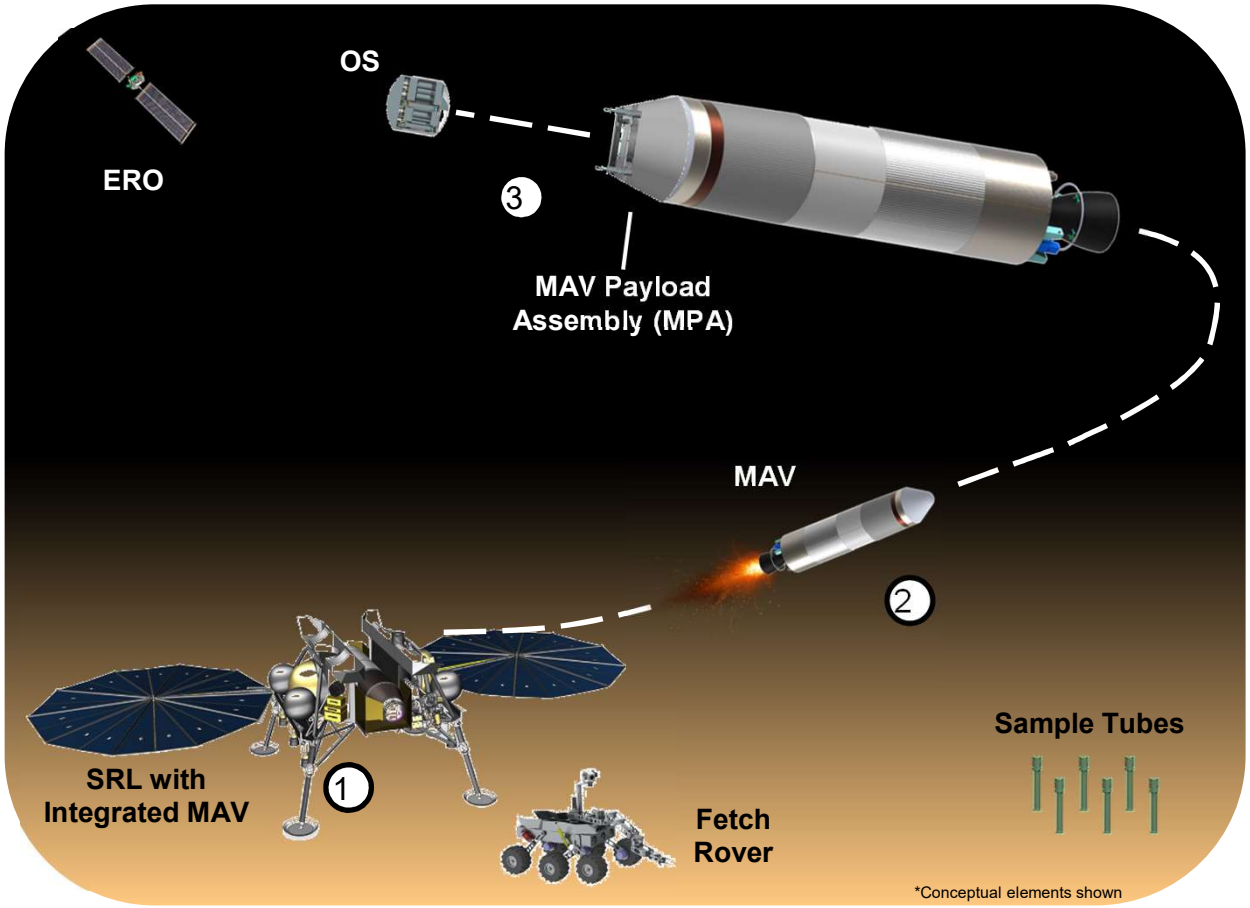
MSR Mission Objective:
Retrieve Mars samples and return to Earth.

1. Mars 2020 rover collects Mars samples and leaves tubes in place.
2. Earth Return Orbiter (ERO) sent to Mars orbit.
3. Sample Return Lander (SRL) with Mars Ascent Vehicle (MAV) sent to Mars. Travel time ~ 2 years.
4. Fetch rover tasked with retrieving sample tubes on Mars surface. MAV dwell time in SRL on Mars ~1 year.
5. MAV is loaded with the Orbiting Sample (OS) containing the sample tubes. MAV carries the OS to Mars orbit.
6. ERO rendezvous with OS, retrieves OS, and returns OS to Earth.
7. Earth Entry System (EES) returns OS to Earth's surface.

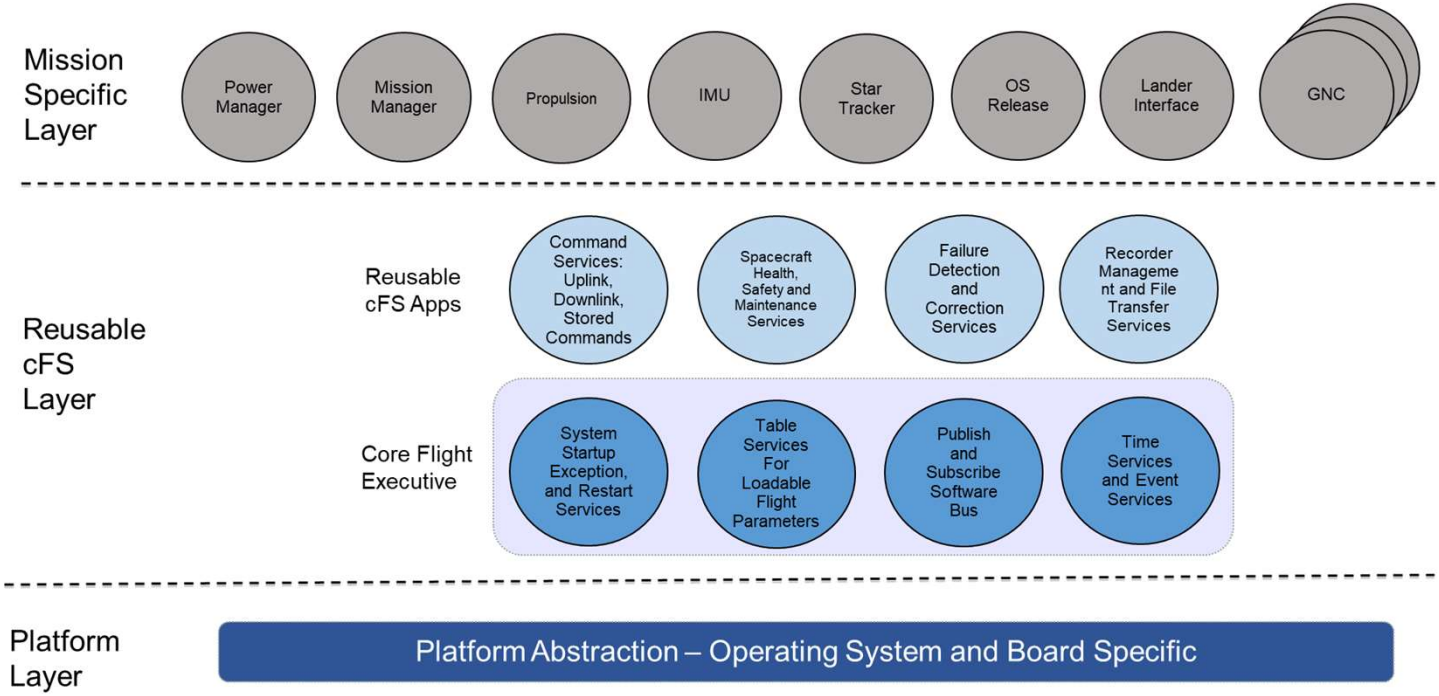


Conceptual MAV Mission Objectives

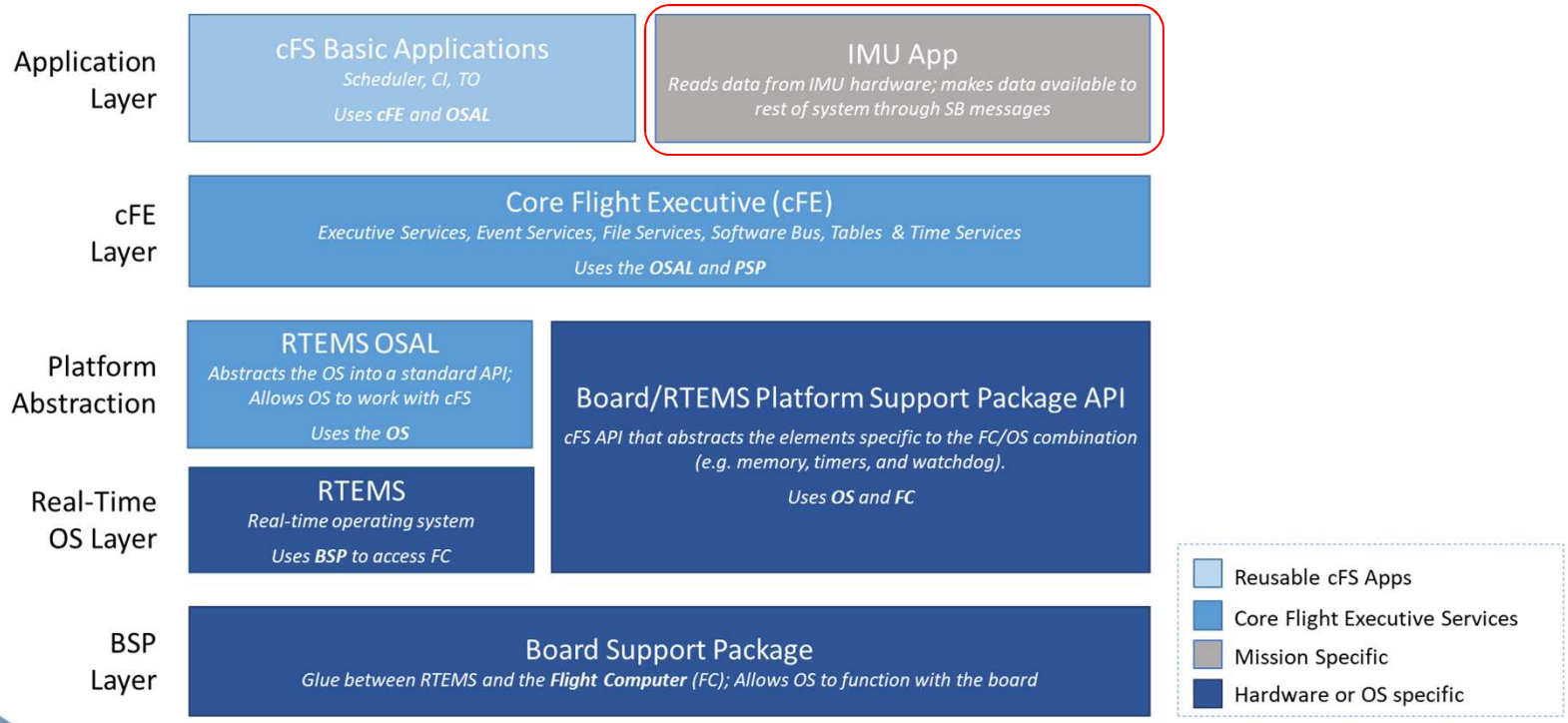
1. Receive sample tubes inside OS on Mars surface.
2. Launch OS to predefined Mars orbit.
3. Release OS in Mars orbit.



Scope and Objectives



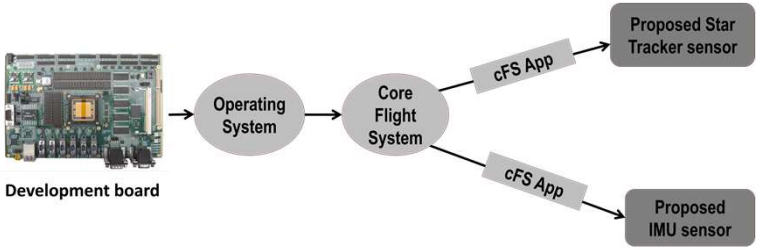
Notional Software Architecture

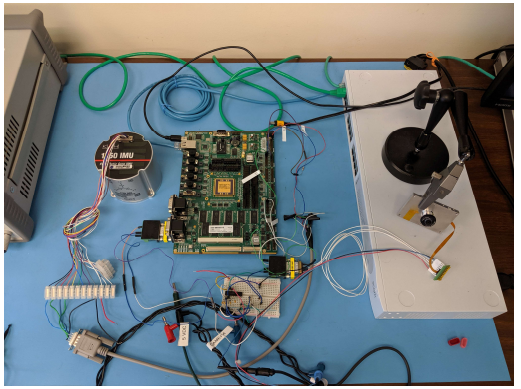


Prototype Software Architecture

Preliminary Lab Setup

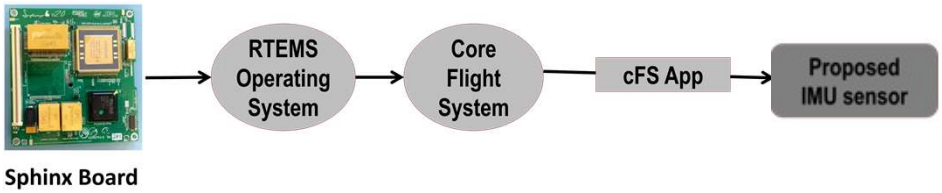
- GR712RC LEON3 Development Board running:
  - Real-time Executive for Multi-processor Systems operating system (RTEMS)
  - Core Flight System (CFS)
  - cFS applications developed for Lunar CATALYST partners and in-house cFS Software Testbed projects
- Converted Star Tracker code from the Iodine Satellite (iSAT) to cFS and ran in REST simulation framework

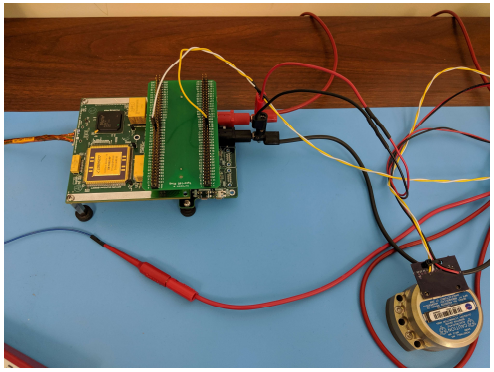




Final Lab Configuration

- Sphinx prototype board running:
  - Real-time Executive for Multi-processor Systems operating system (RTEMS)
  - Core Flight System (CFS)
  - Notional MAV IMU application





Technical Results Summary

- Managed project work using agile methodology across 10 project sprints
- Reviewed documentation for MAV mission and Sphinx Flight computer
- Assessed catalog of existing cFS applications and developed notional flight software architecture for MAV as part of the Preliminary Architecture Assessment
- Setup GR712RC LEON3 development board on loan from JPL and ran cFS on RTEMS operating system on the board
- Developed draft requirements, design diagrams, and source code for IMU application
- Setup and performed troubleshooting on Sphinx Flight Computer board in SPRITE lab, then ran cFS on RTEMS operating system on the board
- Tested that IMU application receives data from the IMU hardware via vendor provided software and on the Sphinx
- Completed analysis of data structure for various IMUs being considered for MAV

- TIP project concluded in October 2019
- MAV activity is expected to receive Authority to Proceed in 2020
- Prototype development conducted during TIP informs early MAV trade studies on software architectures
- Knowledge gained allows MSFC software engineers to be better prepared for cFS software development projects

Next Steps